

Abdera's Arguments for the Atomic Theory

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HISTORICAL LINKS between one school of philosophy and its predecessor must have a certain intrinsic logic if they are to carry conviction. Yet there seem to be instances where a logic overconfident of its powers and oblivious of our very limited knowledge constructs links and influences which, while theoretically possible, are yet on closer examination found to be arbitrary. Long-held opinions about the origin of the atomic theory in the minds of Leucippus and Democritus may be a case in point.

Although Guthrie does not endorse these opinions in their traditional form, he offers a convenient report about them.¹ Dealing with Melissus, and having discussed his relations with Empedocles and Anaxagoras, Guthrie continues: "Finally there are the atomists. In this connexion much has been made of the conclusion expressed by Melissus in fr.8: 'If there were many things, they would be such as the One is.' It is commonly held that the atomism of Leucippus and Democritus was a response to this challenge: there were many things with the properties of the Eleatic One—indestructibility, homogeneity, indivisibility, lack of internal change—though they were microscopic in size and innumerable." Guthrie next points out that these entities move (for the concept of empty space has been re-established), and by combining build up the variety of physical objects. He concludes this paragraph: "Except for the reference to Melissus, this

¹ W. K. C. GUTHRIE, *A History of Greek Philosophy II* (Cambridge 1965 [hereafter 'Guthrie']) 117, referring to J. Burnet, *Early Greek Philosophy*⁴ (London 1930) 335, and to G. S. Kirk and J. E. Raven, *The Pre-Socratic Philosophers* (Cambridge 1957) 306, 406. We may add C. Bailey, *The Greek Atomists and Epicurus* (Oxford 1928) 44f. The second edition of Kirk and Raven (with M. Schofield [Cambridge 1983]), offers a more complicated account (408f) but arrives at an unqualified endorsement of Aristotle's construction (409 n.4: "excellent historical sense"; no question of "overschematization"). In conformity with such opinions Melissus has in the new edition been removed from the neighborhood of Parmenides and Zeno and given a place after Anaxagoras and Archelaus and immediately preceding the atomists. The wisdom of this decision is open to serious doubt.

is, roughly, Aristotle's account of the atomic theory, and there is no reason to doubt it."²

Before we look at Aristotle's authoritative account, we must, in fairness to Guthrie, take notice of his departure from what he presents as widely-held opinion. His own reconstruction runs thus (39): "Leucippus looked rather [*scil.* than to Melissus] to Parmenides, whose theory he modified only in the minimal way³ just mentioned. What exists must still be ungenerated and imperishable, unchangeable, incapable of being added to or subtracted from, homogeneous, finite and a plenum, continuous and indivisible." And there must be void, and "the sensible world [can] be accounted for on the supposition that there are millions of such solid imperishable entities."

The Aristotelian passage that has encouraged these reconstructions is *De gen. et corr.* 1.8 (325a23–32):

Λεύκιππος δὲ ἔχειν ᾤθηται λόγους, οἷτινες πρὸς τὴν αἴσθησιν ὁμολογούμενα λέγοντες οὐκ ἀναιρήσουσιν οὔτε γένεσιν οὔτε φθορὰν οὔτε κίνησιν καὶ τὸ πλήθος τῶν ὄντων, ὁμολογήσας δὲ ταῦτα μὲν τοῖς φαινομένοις, τοῖς δὲ τὸ ἓν κατασκευάζουσιν ὡς οὐκ ἂν κίνησιν οὔσαν ἄνευ κενοῦ, τό τε κενὸν μὴ ὄν καὶ τοῦ ὄντος οὐδὲν μὴ ὄν φησιν εἶναι· τὸ γὰρ κυρίως ὄν παμπλήρες ὄν· ἀλλ' εἶναι τὸ τοιοῦτον οὐχ ἓν, ἀλλ' ἄπειρα τὸ πλήθος καὶ ἄορατα διὰ σμικρότητα τῶν ὄγκων. ταῦτα δ' ἐν τῷ κενῷ φέρεσθαι (κενὸν γὰρ εἶναι) καὶ συνιστάμενα μὲν γένεσιν ποιεῖν, διαλυόμενα δὲ φθορὰν.

It need not be pointed out how much Guthrie and others owe especially to the last sentence of this section. In listing a considerable number of qualities of Parmenides' *έόν* that survive in the atom, they have gone beyond Aristotle but they have stuck close to his method.

What is this method? It may be defined as the construction of a historical development by separating what in the transition from one system to another remains unchanged from what is altered. The results are undeniably of interest provided they are used with caution and not for the wrong purpose. The purpose for which they should not be used is the inference of motives, intentions, and deliberate strategies from the final product. Even if the doctrines of the Abderites were known in their original wording and in their initial form, they would not necessarily disclose what questions, considerations, or desires prompted their enterprise. That the Eleatic, and in particular Parmenides', definition of the *έόν* furnished criteria of reality must be admitted. And given their paramount importance, the Eleatics may well have contributed more.

² Guthrie 117; *cf.* 392.

³ *Sc.* by replacing one entity fulfilling the condition by an infinite number of them.

Jonathan Barnes, besides clearing away misconceptions about ancient atomism,⁴ has the merit of pitting the Abderites against Zeno rather than against Parmenides or Melissus. With good reasons, although with less than complete success, he looks for Democritus' reply to Zeno's dichotomy. At the same time Barnes, far from dismissing the other Eleatics, gives the Parmenidean legacy the full measure of its due: "The atomists asked themselves what were the properties of *onta qua onta*. . . . Every substance, they argued, was unitary . . . and solid. What is solid is by physical necessity indivisible or atomic . . . eternal . . . and also immutable or impassive" (50). In content this description is correct; regarding its form I object less to the mildly anachronistic use of Aristotelian terms than to the assumption that we know what question started the atomists on their search.

Is it at all possible to find in Aristotle, his ancient commentators, or in any other author trustworthy information about the motives that produced the atomic theory? Aristotle *De gen. et corr.* 1.2 (316a14–317a2) is the passage that has attracted most attention and has been analyzed with the most optimistic expectations. But the assessments differ greatly. It is called by Barnes, where he summarizes, "an involved argument of Zenonian flavor," described four pages later as "Aristotle's in form even if it is not so in substance," and again shortly afterwards as "Democritus' reply to the Zenonian argument by positing physically indivisible atoms."⁵

Each of these three parties—Zeno, the Abderites, and Aristotle—has its sponsors, and some scholars are confident that they may recover the outlook of more than one party.⁶ Evidently we cannot move ahead before we know with whose deliberations we are here dealing. As the section is too long to be copied, I shall try to convey its gist by as unbiased a summary as proves possible. The section is preceded by an emphatic—in fact brutally emphatic—declaration of Democritus'

⁴ *The Presocratic Philosophers* II (London/Boston 1979 [hereafter 'Barnes']) 40–75. I appreciate particularly the virtual removal from consideration of theoretical and mathematical divisibility. My observations suggest that the Abderites' concern is strictly physical. 'Parts of the atom' are an Epicurean innovation; see 68f *infra*.

⁵ Barnes 52, 56f. Note also his comment after reporting the conclusion of Aristotle's disquisition: "Zenonian anxiety causes the spots of atomism" (52).

⁶ For Zeno see, besides Barnes' inclination towards him, Bailey (*supra* n.1) 72. The Abderites are favored by H. H. Joachim, *Aristotle on Coming to Be and Passing Away* (Oxford 1922) 76 *ad* 316a13ff; D. J. Furley, *Two Studies in the Greek Atomists* (Princeton 1967) 83; and Guthrie 503f ("Democritus' point-by-point reply to the Eleatics"; Guthrie provides further references). R. Sorabji, *Time, Creation, and the Continuum* (Ithaca 1983) 336ff, finds here Zeno's challenge and Democritus' reaction. In favor of Aristotle, note Harold Cherniss' admirable caution, *Aristotle's Criticism of Presocratic Philosophy* (Baltimore 1935) 113; and see also J. Mau, *Zum Problem des Infinitesimalen bei den antiken Atomisten* (Berlin 1954) 25ff.

superiority to Plato (*scil.*, in devising a theory of indivisibles) because as a man thoroughly conversant with physical subjects he chose as first principles some of wider scope (or applicability).⁷

The subject of the disquisition in 316a14ff is a body or magnitude regarded as divisible through and through (*πάντη διαιρετόν*). Such breaking up in every place—and in every place simultaneously—is pronounced to be perfectly possible even if it is unlikely to happen (a22f). What would be left? Certainly not a body or any kind of magnitude or extension. Rather what results from such complete division is either nothing at all or points (a25–29). On either assumption, it proves impossible to put the magnitude again together (a third possibility, *scil.*, that something in the nature of sawdust develops in the dividing, and evaporates, is briefly envisaged, and dismissed as contributing nothing to a solution, a34–b2).⁸ Since the experiment has led to such unsatisfactory results (for *ἄτοπον ἐκ μὴ μεγεθῶν μέγεθος εἶναι*, b4, b14ff; and points are not *μεγέθη*), the theory of indivisible magnitudes appears to be inescapable (b14–16; the same conclusion, b29–34). Yet this theory too is open to objections, for which we are referred to other treatises.⁹ A way out of the dilemma must be found and can be found. On renewed consideration, the complete breaking-up of a body everywhere—the premise of the whole argument—is seen to be not only actually but even potentially impossible. Potentially because the breaking up of the whole body into points (*στιγμαί*) would be conceivable only if points were contiguous and through their contiguity could compose a body. The truth is that points do not touch (317a2–12, 12–14).

A close study of this section with attention given not only to its thought but also to its style, and most of all to the temperament displayed in it, removes all doubt that we are confronted with Aristotle's own intellectual efforts. The vividness and the zeal with which he explores every aspect of the question and pursues it into every corner

⁷ 316a5–14. Words like *Δημόκριτος δ' ἂν φανεῖη οἰκείους καὶ φυσικοῖς λόγοις πεπεῖσθαι* (a13f) prompt the unwary to think that a report about Democritus' arguments will follow. Actually by *δηλον δ' ἔσται ὃ λέγομεν προϊούσιν· ἔχει γὰρ ἀπορίαν . . .* (14), Aristotle himself takes over. The reference to Democritus' arguments is motivated by the contrast with Plato. E. Asmis, *Epicurus' Scientific Method* (Ithaca 1984) 254ff, understands a14 differently and proceeds to an interpretation of the argument that leaves me unconvinced. Lucretius 1.540–50, 588–83, which she compares, is not similar.

⁸ Still another possibility—that owing to a special *πάθος* or *εἶδος* points could build up a body (316b12–15)—may here be ignored.

⁹ Serious objections are developed in *De caelo* 3.4 (303a3–b8). An objective that Aristotle pursues throughout *De gen. et. corr.* 1.3 is to show that even if atomism were a tenable doctrine it could not account satisfactorily for genesis; for true and “simple” genesis does not come about through *σύγκρισις* (see 317a12ff, esp. 17–22).

do not leave us with the impression of an author who serenely reports about other thinkers' problems and predicaments. There is nothing here of the continuous and progressive decrease of the cut-off parts: not only do we fail to find the characteristic words ἀπέχον and προέχον;¹⁰ the breaking-up Aristotle describes is of a quite different type. He imagines a magnitude breaking up everywhere simultaneously,¹¹ and, in order to bring out the awkward conditions he sees arising, he operates repeatedly—at first implicitly, yet at the end quite frankly and openly—with his characteristic antithesis of *dynamis* and *entelecheia*.¹² Moreover, behind the thought experiment here performed are Aristotle's own conceptions of every continuum (συνεχές) as divisible, and, more importantly, of points (στιγμαί) as having no extension, being unable to touch one another, adding nothing to a magnitude and therefore incapable of building up a continuum. Points as the final result of a division are not known to have figured in Zeno's paradoxes or in the Abderites' arguments for the atom; yet this is the hypothesis on which Aristotle's argumentation, throughout a good part of the section, is predicated. Whether Aristotle and Zeno agree in holding that a 'nothing' cannot produce an increase is of no consequence; nor would it make a difference if the διαίρεσις κατὰ τὸ μέσον at a19 is identical with, or refers to, Zeno's characteristic διχοτομία.

As this section in *De generatione et corruptione* refuses to shed light on the motives behind the Abderite conception of atomic magnitudes,¹³ we have to fall back on the very meager—but, on account of this very meagerness, less suspect—statement at *Physica* 1.3 (187a 1ff):

ἔνιοι δ' ἐνέδοσαν τοῖς λόγοις ἀμφοτέροις, τῷ μὲν ὅτι πάντα ἐν εἰ τὸ ὄν ἐν σημαίνει, ὅτι ἔστι τὸ μὴ ὄν, τῷ δὲ ἐκ τῆς διχοτομίας ἄτομα ποιήσαντες μεγέθη.

That the ἔνιοι who made such concessions to the Eleatic challenges are the Abderites has been generally recognized since Burnet and W. D.

¹⁰ Zeno 29B1 D.-K. The meaning of these words has not been cleared up beyond doubt. The best explanation may be G. Vlastos' in *Gnomon* 32 (1959) 196ff (=R. E. Allen and D. Furley, ed., *Studies in Presocratic Philosophy* II [London 1975] 177ff). The term ἀπέχοντα in 316b29 suggests a condition of separation and can hardly have the same meaning as in the Zeno passages.

¹¹ 316a15ff, 17ff (ἄμα, 19ff). Sorabji (*supra* n.6: 338) notices the incongruity between division everywhere and infinite division.

¹² 316a15ff, b19–24. Cf. Mau (*supra* n.6).

¹³ I see no need to discuss *De gen. et corr.* 325a23–b5 (included in 67A D.-K.), a section that sets forth essential theories of Leucippus, stressing the divergence from, and opposition to, Eleatic doctrines. There is no statement referring to the origin of the Abderite position.

Ross¹⁴ explained the passage in this sense. They 'yielded' to the Eleatic monism by asserting reality for the $\mu\eta\ \delta\upsilon\nu$ and they posited indivisible magnitudes in response to Zeno's 'cutting'. Aristotle has been engaged in a critical scrutiny of Eleatic ontology ever since 184a15, but Zeno's dichotomies have not yet been mentioned. The sudden and completely unprepared appearance in 187a1ff of the $\lambda\acute{o}\gamma\omicron\varsigma\ \acute{\epsilon}\kappa\ \tau\eta\varsigma\ \delta\iota\chi\omicron\tau\omicron\mu\iota\alpha\varsigma$ increases the probability that it (cautiously put) played some part in calling the atomic theory into existence. Do we find support for this impression?

One piece of support is immediately available. The very word $\acute{\alpha}\tau\omicron\mu\omicron\nu$, often translated 'indivisible', means literally 'uncuttable'. Should we not read this term as a protest and barrier erected against Zeno's $\tau\omicron\mu\eta\ \acute{\epsilon}\iota\varsigma\ \acute{\alpha}\pi\epsilon\iota\rho\omicron\nu$? Probably yes. But having expressed distrust of intentions or motivations constructed by modern scholars we need to ask two questions: do we find any information on why the Abderites wished to bring Zeno's $\tau\omicron\mu\eta$ to a halt? and what justification did they claim for deciding one stage in this $\tau\omicron\mu\eta$ to be the final one?

Lucretius 1.551-64 may suggest the answers:

*denique si nullam finem natura parasset
frangendis rebus, iam corpora materiai
usque redacta forent aevo frangente priore
ut nil ex illis a certo tempore posset*

555 *conceptum summum aetatis pervadere finem.
nam quidvis citius dissolvi posse videmus
quam rursus refici; quapropter longa diei
infinita aetas anteacti temporis omnis
quod fregisset adhuc disturbans dissolvensque*

560 *nunquam relicuo reparari tempore posset.
at nunc nimirum frangendi reddita finis
certa manet quoniam refici rem quamque videmus
et finita simul generatim tempora rebus
stare quibus possint aevi contingere florem.*

Clearly what these lines proclaim is the need to erect a safeguard against Zeno's $\tau\omicron\mu\eta\ \acute{\epsilon}\iota\varsigma\ \acute{\alpha}\pi\epsilon\iota\rho\omicron\nu$, to establish a *finis certa* as the necessary alternative to *nulla finis frangendis rebus*. It is a physicist's reply and perhaps simpler and less sophisticated than what some of our contemporaries have constructed as the intellectual foundation for atomism. It is also less sophisticated than the case that Aristotle builds up—and immediately proceeds to invalidate—for indivisible magnitudes.¹⁵

¹⁴ Burnet (*supra* n.1) 335ff; W. D. Ross, *Aristotle's Physics* (Oxford 1936) 480ff.

¹⁵ While formulating the case for Abderite origin, I am far from denying that in the

The point here made is that nature cannot allow the breaking-up to continue ad infinitum, and that no theory of nature can be devised on such a basis. To be sure, for the actual concept of the atom, as distinct from the relatively vague idea of a *finis frangendi*, we need more specific arguments. But before looking for them we may as well complete our diagnosis of this section in Lucretius. The physicists who found it necessary thus to protect their enterprise against theories apt to render it futile are, to judge by the tenor of their protests, the Abderites, and we may even think of the founder of the school, Leucippus, as the author of this protest¹⁶ (though on the whole I have found it unprofitable in this paper to distinguish between his thought and that of Democritus). Historically and chronologically it makes far better sense to pit the Abderites against Zeno than to assign this rôle to Epicurus, who had quite different adversaries to contend with.¹⁷

The *μέγεθος* discussed by Zeno in 29B1 does not give the impression of a physical object, nor are the parts that continue to emerge described as results of a physical act of breaking, cutting, or destroying.¹⁸ Very understandably, however, the physical philosophers perceived a bearing of this *Grundlagenkrise* upon their province of thought. Anaxagoras, to judge by 59B3, saw his way to absorbing the results. The Abderites did not.

For a physical body of three dimensions 'breaking' (*frangere*) seems a more appropriate word than 'cutting' (*secare*, which in a context like that of 5.559 would look rather odd if it were to occupy the place of *frangere*). Still the choice of *ἄτομον* instead of, say, *ἄρρηκτον* proves that Zeno's *τομή* created the issue. There are noteworthy instances of amicable association between 'cutting' and 'breaking' in Lucretius. In the listing of all threats to which the atom is immune (1.528–35), we meet *nec fragi nec findi in bina secando* (= *διχοτομία*, 533), *i.e.*, the two concepts in question placed side by side. And towards the end of Book 1, in the polemic against Empedocles and other pluralists, we find one of their principal errors specified (746–48):

various stages of transmission from, say, Democritus to Lucretius erosion has been at work, leaving us with the skeleton of an argument that had been more subtle and elaborate.

¹⁶ For Leucippus' opposition to Zeno *cf.* Bailey (*supra* n.1) 73.

¹⁷ Asmis (*supra* n.7) 236 says quite correctly: "By the time of Epicurus the controversy provoked by the Eleatic arguments on being had subsided. The early atomists . . . were clearly at the center of the controversy." To identify Epicurus' adversaries is not easy, *pace* Furley, *BICS* 13 (1966) 13ff. I still include the Stoics among them, though I agree about the superior importance of Plato and Aristotle, especially the exoteric Aristotle. About the relations between Epicurus and the resuscitated Megarians, I look forward to further enlightenment.

¹⁸ *Cf.* G. Vlastos in W. Kaufman, ed., *Philosophical Classics* (New York 1962) 31.

*deinde quod omnino finem non esse secandis
corporibus faciunt neque pausam stare fragori
nec prorsum in rebus minimum consistere quicquam.*

Anaxagoras is more simply criticized for not allowing *corporibus finem esse secandi* (884). These polemical sections are Epicurean in origin and so is the list of fatal dangers in 528–35.¹⁹ Given Epicurus' adherence to most of Democritus' physical doctrines²⁰ it is not astonishing if an association of concepts that had been especially meaningful for the Abderites survives in Epicurus' texts. Some readers may prefer to conclude that it was Epicurus who substituted 'breaking' for 'cutting' and changed the concept of a *finis secandi* into a *finis frangendi*. I have given much thought to this alternative interpretation of the evidence but cannot help regarding *frangere* as the obvious word appropriate for a three-dimensional object.

The suggestion that Epicurus adopted—along with the concept of the atom—an original argument for its necessity may meet with some resistance. Actually the situation is more complex. At a later point in this paper when studying Epicurus' own derivation of the atom, we shall find him reaching his goal along quite different lines and observe that his defense against infinite divisibility has been removed to the discussion of another problem. Our new suggestion about the origins of the atomic theory may well be in need of further clarification and refinement, but it seems entitled to a place beside the explanations so far in vogue, based as it is on an authentic atomist text and having less recourse to speculation.

Because it was imperative to give the terminal point of the division a maximum of stability, the *atomon* was declared unchanging and eternal. In Lucretius *soliditas* and *aeternitas* are inseparably tied to one another; in Epicurus himself *στρερά* and *ἀδιάλυτα* are concepts similarly connected.²¹

With *aeternitas* most of the other predicates of Parmenidean reality listed above (59) establish their hold on the atom. *Simplicitas* and *immutabilitas*, which stand out in the text,²² may be assumed to carry

¹⁹ As W. Rösler has shown in his masterly article, "Lucrez und die Vorsokratiker," *Hermes* 101 (1971) 48ff, the polemical sections (1.635–910) go back to an Epicurean version (or adaptation) of a Hellenistic doxography.

²⁰ On 1.526ff see 71f *infra*.

²¹ See 1.500, 518ff, 538f, 577–83, etc.; Epicurus *ad Herod.* 54. Epicurus inherited these qualities from the Abderites. For the Eleatic origin cf. the theories of Guthrie and others recorded above (59f). None of these theories makes allowance for the *finis frangendi* motif (or motive). It seems correct to say that Parmenides was used to counteract Zeno.

²² *Simplicitas*, 1.542, 574, 612; *immutabilitas*, 591–98; cf. 670ff. Note, however,

many or most of the others with them. In the transition, however, from a sublime reality far removed from all secular concerns to a minimal entity needed as safeguard, these predicates change their status. While losing dignity they acquire concreteness. The distance is large between the *έόν*, which Parmenides called *ἀναρχον ἄπανστον* and by sublimely simple logic saved from genesis and destruction,²³ and the Democritean or Epicurean atoms which cannot be broken either from the outside or from the inside, and which remain unharmed by moisture, fire, and “spreading cold.”²⁴ They are eternal because they are impenetrable, and they owe their impenetrable quality to their hardness. Surely the substitution of many or countless *όντα* for one was not the only change Parmenides’ reality underwent when passing from Elea to Abdera. *Simplicitas*, which conveniently sums up various original Eleatic predications,²⁵ might seem more appropriate to the partless atom of Democritus than to the Epicurean which has acquired parts; still Lucretius does not hesitate to emphasize *simplicitas* in the very same paragraph in which he describes the *partes* (1.599–612; note especially 606–12). Inasmuch as the *partes* are not separable and the atom remains intrinsically homogeneous, the continued use of *simplicitas* for it seems, after all, justified.

Having discovered what appears to be an Abderite argument, we wonder whether in the neighborhood of it there may be lurking one or several others that may likewise be restored to the ‘inventors’.²⁶ Zeno’s relentless divisions must somehow be reflected in the reasoning of 1.615–27:

615 *praeterea nisi erit minimum, parvissima quaeque
corpora constabunt ex partibus infinitis,
quippe ubi dimidiae partis pars semper habebit
dimidiam partem nec res praefiniet ulla.
ergo rerum inter summam minimamque quid escit?*

that the paragraph in which the *finis* is established (551–64) includes no reference to *soliditas*, *aeternitas*, or *simplicitas*. This difference from all preceding arguments (503–50) and from the program in 499f alerts us to the argument’s peculiarity, which, I believe, is explained by my hypothesis of its original purpose.

²³ B8.27. Note also 8.2–4, 8, 19–21, and in 8.29 καθ’ ἑαυτό τε κείται.

²⁴ See Lucr. 1.528–35.

²⁵ In B8.22–25, οὐδὲ διαιρετόν, πᾶν ὁμοῖον, and συνεχές are particularly significant.

²⁶ The argument of 1.577–83 that is also directed against *nulla frangendis reddita corporibus finis* must be closely related to the thought of 551–64. One may wonder whether someone decided to give the *reductio ad absurdum* a slightly different form. The reasoning is reminiscent of 232–37. In both passages I seem to find ἀντιμαρτύρησις, a method illuminatingly discussed by Asmis (*supra* n.7) 143 and *passim*; cf. her index s.v. “counter-witnessing.”

- 620 *nil erit ut distet; nam quamvis funditus omnis
summa sit infinita, tamen parvissima quae sunt
ex infinitis constabunt partibus aequae.
quod quoniam ratio reclamationem vera negatque
credere posse animum, victus fateare necessest*
- 625 *esse ea quae nullis iam praedita partibus extent
et minima constant natura. quae quoniam sunt,
illa quoque esse tibi solida atque aeterna fatendum.*

Here again the threat that must be faced and eliminated is division going on ad infinitum, although the protest is this time not uttered in the interest of nature and a theory of nature but on behalf of *ratio vera*. The unwelcome and absurd condition here pointed out, *scil.*, no difference between the largest and the smallest,²⁷ is the direct outcome of Zeno's cutting. Intended originally, we may suppose, as a paradox, a provocation and a cause of embarrassment, it has now become serviceable to a theory that escapes this state of things. Anaxagoras' "Of the small there is no smallest" inevitably comes to mind; for even if, as Furley maintains, it has a different orientation²⁸ it yet reflects (as does the reference to *τομή* in the same context) the perspective created by Zeno's intellectual adventures. For Lucretius the *miminae partes* at which he insists the division must stop are not the atoms themselves, but the atom's parts with which he has acquainted us in the paragraph immediately preceding (1.599–614).²⁹ Whatever Epicurus' reason for introducing something smaller than the atom,³⁰ it is hard to imagine that the *minimae partes* were in their original conception meant to serve as terminus for the Zenonic *τομή*. The atom itself as the minimum that rescues physics from the Zenonic predicament makes excellent sense and involves no historical or chronological improbability. To the atom and its *soliditas* we are actually brought back

²⁷ Bailey (*supra* n.1: 72 n.2) speaks of Lucretius as "employing" here a "half" of Zeno's argument against infinite division. But in his commentary, *Titi Lucreti Cari de rerum natura libri sex* (Oxford 1947) II 703, he describes the proof of 1.615–27 as "a commonplace paradox in antiquity." The fullest collection of evidence known to me is in Sorabji (*supra* n.6) 343ff, esp. 344 n.18.

²⁸ *Supra* n.6: 37, with reference to S. Sambursky, *The Physical World of the Greeks* (London 1956) 22.

²⁹ By focusing on Lucretius' procedure I do not mean at all to exclude his dependence on a Greek source.

³⁰ Furley (*supra* n.6: chapters 1, 2, and 8) has, in my opinion, made some advance without solving the problem completely. Lucretius 1.631–34, if in part obscure, does provide some rough indication why atoms must have parts. Most of the conclusions reached by Vlastos in his comprehensive discussion of the *minimae partes* (*Isis* 54 [1965] 121ff) seem to me convincing, but I am at a loss how to reconcile Lucretius' indications with the line of thought Vlastos pursues.

at the end of this argument, by a turn of thought that comes most unexpectedly and lacks logical cogency as well as subtlety (1.626f). The very awkwardness suggests that the move was necessary. The atom was the end and essence of the argument.

Although we may not reach the same degree of confidence, it seems worth pondering whether the argument of 1.565–76 also goes back to the original proponents of atomism. The atoms, it is here argued, while themselves hard, offer no obstacle to a perfectly satisfactory account of soft (*mollia*) objects. All that is needed is the presence of void between the *solida*. By contrast, physicists who posit *mollia primordia rerum* (570) are unable to account for the existence of hard objects since no composition of *mollia* may conceivably produce them. It is not easy to believe that this benefit of their invention should have escaped Leucippus or Democritus, whose ἀρχαί could thus be considered superior to those of their contemporaries and ‘rivals’—Empedocles, Anaxagoras, and perhaps still others. Even so, our attempt to claim the contents of these lines for the Abderites remains in the realm of conjecture.³¹

Our study of Lucretius 1.551–64 prompted the question what kind of place and what degree of importance the insistence on a *finis certa* might have in the system of Epicurus. His own *Letter to Herodotus* shows by what road he arrived at the atom. Lucretius’ Book 1 moves by parallel steps, and as it is fuller and offers for our purposes more helpful information, we shall use it as a basis for our reconstruction, and, after gaining from it as much light as it may yield, turn to the *Letter* to see how far it bears out our conclusions.

We need not analyze the entire development of doctrine between 1.149 and 1.550. A few highlights will suffice. In 151–214 Lucretius establishes the axiom *nihil e nihilo gigni*, and in 215–64 the complementary one, *nihil ad nihilum interire*. These are traditional Presocratic topics.³² In the latter—*nihil interire*—the Epicureans (to put it

³¹ I am aware of two objections. In the polemical sections at the end of Book 1, the disadvantages inherent in *mollia principia* are played off against Empedocles (1.743 and 753ff) and Anaxagoras (847ff). If these sections are a product of the Epicurean school composed in reliance on a doxography (cf. Rösler [*supra* n.19] 448ff), I see no reason why the author(s) should refrain from using Abderite thoughts (or Abderite criticisms of rival systems). More serious may be a point raised by my friend Peter M. Smith: Empedocles B73, where the bones are hardened by the agency of fire, and perhaps some other passages in Empedocles show what can be done with *mollia principia*. May one suppose that Democritus ignored such instances?

³² See, among others, Parmenides B8.6–11; Empedocles B12; Anaxagoras B17. For an exhaustive account see Robin’s note in A. Ernout and L. Robin, edd., *Lucretius, De rerum natura* (Budé: Paris 1925) ad 1.150. For the Abderites the meaning of μὴ ὄν excludes genesis from it and passing into it. Cf. Guthrie 29f.

cautiously, although most probably it was the master himself) introduced some modifications, two of which should here be recorded. Everything that comes to be and passes away has its specific, *certa, materies*; and this *materies* does not perish, but is eternal (*aeterna*).³³ Like the Stoics, the Epicureans have borrowed the extremely useful *hyle* concept from Aristotle,³⁴ yet the notion of *materies aeterna* presents a remarkable new departure, which so far as I am aware has failed to receive due attention.³⁵ We shall find this concept and the reasoning behind it taken up again and given a precise meaning after the existence and peculiarity of the *primordia* have been settled.

Presocratics after Parmenides were agreed on replacing genesis by combination, and destruction by separation.³⁶ For Epicurus, whatever his views of genesis,³⁷ combination (*σύνκρισις*) remains of cardinal importance. Lucretius 1.483f introduce the basic distinction: *corpora sunt partim porro primordia rerum partim concilio quae constant principiorum*.³⁸ While the Abderites posited atoms and the void as the basic reality and *archai* of their system, Epicurus begins instead with *corpora* and the void, and from the *corpora*, by the distinction just quoted, works his way to the atoms (*primordia*).³⁹ For the approach to the latter this makes no small difference.⁴⁰ When Lucretius

³³ For *certa materies* and *certa semina* see 1.167–71; also 173, 176, 189, 203f. For *aeterna semina*, 221; *materies certa*, 239; *aeterna*, 239, 245, 518f, 540.

³⁴ H. Usener's *Glossarium Epicureum*, edited by M. Gigante and W. Schmid (Rome 1977), lists for ἄλη *ad Pyth.* 93 and 112, as well as passages from the *Volumina Herculanensia*, one of which (X 95) is still attributed to Epicurus by the editors. In G. Arrighetti, *Epicuri opera*² (Turin 1973) I find ἄλη confidently deciphered or restored three times in an unidentified book of Epicurus (32.8.6; 11.17; 12.18). In associating ἄλη with the name of Aristotle, I do not intend to dissent from the attractive opinion that the concept was used also by other members of the Academy in the last decades of Plato's life. It may have been appreciated as a very serviceable alternative to Plato's χώρα. Cf. now especially F. H. Sandbach, *Aristotle and the Stoics* (=PCPS Suppl. 10 [1985]) 34–37 with nn.74–81.

³⁵ Bailey's laconic comment on *materies* (*supra* n.27: *ad* 1.58) shows little awareness of the historical background. It may be awkward to avoid the use of the word 'matter' in dealing with the physics of, say, Anaxagoras or Democritus, but indiscriminate resort to this term is bound to create confusion. Sorabji (*supra* n.6: 357) mentions the Epicurean *materies aeterna* without comment.

³⁶ See Empedocles B8f, Anaxagoras B17, Democritus A37; there is a good deal of less explicit evidence.

³⁷ For the rehabilitation of genesis in Plato and Aristotle see F. Solmsen, *Aristotle's System of the Physical World* (Ithaca 1960) 44ff, 74, 321ff.

³⁸ The return to *corpora* at 483 is in order, since at 329 Lucretius has broken off his discourse on *corpora* to deal with the void and some other aspirants to reality whose claims he rejects (449–82). His first and more general discussion of *corpora*, which ends at 329, while its beginning is less easy to determine, poses problems that will be discussed elsewhere.

³⁹ See Democritus B8 and 125; Epicurus *ad Herod.* 40.

⁴⁰ 1.485 sets the tone for what follows: note 499–502.

after 1.483f focuses on the *primordia*, their rôle as *finis frangendi* is by no means his first concern. What has to be established before anything else is that the *primordia* are firm and unbreakable, *solido corpore*. Along with *soliditas* they acquire *simplicitas* and *aeternitas*. Three arguments (1.505–27) may be intended to prove the *soliditas*,⁴¹ though it is just as possible, and probably even truer to Lucretius' intention, to read them as proving the existence and necessity of the *prima corpora*. All three arguments operate in one way or other with the antithesis between body and void. The first (503–10)⁴² postulates that each of these two must exist *purum* and *per se* (*καθ' ἑαυτά*, 506), the second (511–19) that the void needs to be surrounded and, as it were, protected by a *solidum* (which, as it turns out, is a *concilium* of atoms, but the purpose is served no less well). The third argument (520–27) declares it impossible that either body or void can fill the whole (*omne*); the body that figures in the reasoning is again the *corpus primum* and *solidum*; *solidum* implies that there is no void at all within it.

In 1.528–37 Lucretius, evidently satisfied with his proofs for the existence of the *corpora prima*, dwells on their complete immunity to dissolution.⁴³ None of the common dangers associated with the destructive powers of the elements—water, fire, *etc.*—can possibly affect them. At 540 the argument changes its direction. Recalling what earlier in the Book has been laid down about the *aeterna materies* as being necessary *rebus reparandis* and to prevent destruction *ad nihilum*, Lucretius shows that this requirement of *aeterna materies* is implemented by the *immortali primordia corpore* (545). Their eternity (immortality) and solidity, their function as *materies*, and their capacity—in fact exclusive capacity—*ex infinito iam tempore res*

⁴¹ Bailey (*supra* n.27: 688) is able to make a case for *soliditas* as the demonstrandum of all three arguments. In the second it is noteworthy that *solidum* is also associated with the *concilium materiai*, especially at 1.516f. There may well have been a concern to slow the breaking-up process even before the stage of the atom is reached. Indicative of such a tendency is 238–47. We can hardly decide whether it goes back to the Abderites.

⁴² I share Diskin Clay's uneasy feeling about 1.503–10 (*Lucretius and Epicurus* [Ithaca 1983] 129) but hesitate to conclude that Lucretius devised these arguments himself.

⁴³ Bailey (*supra* n.27: 688) misses the significance of 1.528–39, which for him are “an appendix rather than a digression.” It is correct that *aeternitas* is here secured for the atom, but what matters more is that the atom itself is now regarded as established. This is the reason why in 540ff it takes over the rôle previously assigned to *materies* (as Bailey quite rightly observes *ad* 543). The analysis of 1.503–598 as a sequence of eight proofs (Bailey 684, 690, 694) plus, it would appear, an appendix is misleading since it fails to bring out the special weight of the first three ‘proofs’ that carry the burden of the argument.

reparare (550) have thus been established before the *finis frangendi* is brought into play at 551. Originally, if our reconstruction is correct, the *finis frangendi* had been the argument and quite probably the fundamental argument for the existence and necessity of the atom, while indivisibility, eternity, homogeneity, and other Parmenidean qualities had served to fortify it. Now the Parmenidean qualities create the atom and the necessity to stop the breaking has been relegated to a subsidiary place and function.

In the *Letter to Herodotus*, too, the first principle (*πρώτον*) put down is that nothing comes to be from not-being and that if there were destruction into not-being this would mean the end of all things, for nothing would be left for their restoration. There follows a statement about *σώματα* and *κενόν*,⁴⁴ the mainstay of the entire system, and this in turn is followed by the division of *σώματα* into compounds (*συγκρίσεις*) and “what the compounds are made of”: *ταῦτα δ' ἐστὶν ἄτομα καὶ ἀμετάβλητα εἶπερ μὴ μέλλει πάντα εἰς τὸ μὴ ὄν φθαρήσεσθαι, ἀλλ' ἰσχύοντα ὑπερμενεῖν ἐν ταῖς διαλύσεσι τῶν συγκρίσεων* (41). The phrase *εἰς τὸ μὴ ὄν φθαρήσεσθαι* corresponds to Lucretius' *ad nihilum redire*.

Epicurus adds a further essential requirement for the atom, *πλήρη τὴν φύσιν ὄντα*, and he varies *ισχύοντα ὑπομενεῖν* by *οὐκ ἔχοντα ὄπη ἢ ὅπως διαλυθήσεται*.⁴⁵ At the end of this cardinal section he repeats: *ὥστε τὰς ἄρχας ἀτόμους ἀναγκαῖον εἶναι σωμάτων φύσεις*. Even if no individual word in this paragraph (41) corresponds to *solidum*, *ἀμετάβλητα*, *πλήρη*, *ισχύοντα ὑπομενεῖν*, and the persistent exclusion of *διάλυσις* do the same service. And *ἄτομος* has the full weight of its meaning ‘uncuttable’. (Later on in 54 the atom, while lacking most of the usual qualities, must yet itself remain *στερεὸν καὶ ἀδιάλυτον*; the former of these adjectives corresponds to *solidum*.)⁴⁶

Having settled these fundamental requirements, Epicurus feels justified in embarking on the infinite number of atoms and on various aspects of their behavior. In the course of this account we learn that the process has no beginning, for the atoms (and the void) are *αἴδια* (44), but there is no reference to the *finis frangendi*. A reference to it does occur slightly later (56), where Epicurus takes his stand against the presence of infinitely numerous atoms in a finite object, and in following up this decision declares, *τὴν εἰς ἄπειρον τομὴν ἐπὶ τοῦλαττον ἀναιρετέον ἵνα μὴ πάντα ἀσθενῆ ποιῶμεν κὰν ταῖς περιλήψεσι τῶν ἀθρόων*

⁴⁴ I accept the text as printed in the edition of P. Von der Mühl and G. Arrighetti.

⁴⁵ The differences Clay finds (*supra* n.42: 125f) between *ad Herod.* 40f and Lucretius 1.483–86 do not affect the substance. I appreciate—here and elsewhere—Clay's observations about the forcefulness of Lucretius' language.

⁴⁶ Note also *στερεότης* in *ad Herod.* 44 and, for other occurrences of *στερεόν* in Epicurean texts, cf. Usener (*supra* n.34).

εἰς τὸ μὴ ὄν ἀναγκάζομεθα τὰ ὄντα θλίβοντες καταναλίσκειν.⁴⁷ These clauses and those surrounding them bristle with problems of meaning into which we fortunately need not digress since the feature of special interest to us is not affected by them. It is a surprise to find the μὴ ὄν as terminus of infinite division. Pedantic as it may seem, we must insist on the difference between the frequently occurring motif of disappearance or dissolution into nothing and the progressive ‘breaking’ or ‘cutting’. Both, to be sure, are anathema to physicists, but while the one leaves nothing for the ‘repair’ or rebuilding of things, the other only leaves less and less and does not allow the time needed for rebuilding. Moreover, while *nihil ad nihilum* is common ground for post-Parmenidean physicists, the protest against continuous division points specifically to Abdera.⁴⁸ We may note that Lucretius presents the argument against *ad nihilum* and that against *nulla finis frangendis rebus* in separate, if successive, sections (1.540–50, 551–64). It is futile to speculate whether Epicurus in his authoritative larger work avoided the “contamination” he allowed himself in an epitome, or whether Lucretius here depends on later members of the school who reformed the founder’s arguments.⁴⁹ What matters for us is something different. The stand against the εἰς ἄπειρον τομή is now made to refute the notion of infinitely many atoms present in a finite body. The reality and necessity of the atom have been established on other grounds.⁵⁰

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⁴⁷ Furley (*supra* n.6: 13) translates: “we must . . . do away with division into smaller and smaller parts to infinity, so that we may not make everything weak and in our conception of the totals be compelled to grind away things that exist . . . into the non-existent.” In my view ἀθρόα are compounds, and τὰ ὄντα are not limited to the atoms. There follows in Epicurus’ text another clause excluding a μετάβασις . . . εἰς ἄπειρον ἐπὶ τοῦλαττον. The meaning is very uncertain. Furley (14) may be right in understanding μετάβασις as a ‘traversing’ in one’s mind. What interests us is that the *finis frangendi* has no place in Epicurus’ derivation of the atom.

⁴⁸ Dependence, direct or indirect, conscious or not, on Zeno’s notorious passing from the smallest to nothing (29B1) is a definite possibility. Vlastos (*supra* n.30: 122, 141) presents a critical analysis of what may be Zenonian thought in the *Letter* (56f).

⁴⁹ For A. A. Long, *Hellenistic Philosophy*² (Berkeley/Los Angeles 1986) 32ff, “Infinite divisibility implies nothing about reduction to sheer non-existence. Lucretius avoids this fallacy.” I do not accept all his reports about divisibility but I certainly endorse the observations here quoted.

⁵⁰ On the intellectual level as much as in technical detail, the manuscript owes far more than a few words can express to the wise and patient help of Alexander Mourelatos. In response to his criticism I have modified some of my positions and stated others more precisely. I am also indebted to my colleague Peter M. Smith and, for technical assistance, to Darrel Rutkin.